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Effectiveness of glaucoma diagnosis using optical coherence tomography in patients with unreliable standard automated perimetry test

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ABSTRACT

Context: Glaucoma, a leading cause of blindness in people over 40 years old, involves progressive retinal ganglion cell loss. Early diagnosis and treatment are crucial. Visual Field (VF) testing, though essential, is subjective and variable. Optical Coherence Tomography (OCT) objectively measures Nerve fiber layer thickness, aiding early-stage detection but less effective in advanced stages. OCT's objectivity benefits rural and less educated population where Standard Automated Perimetry (SAP) results are often unreliable.
Aims: 1) To determine the percentage of unreliable standard automated perimetry test. 2) To analyze the socio-demographic factors of patients with unreliable standard automated perimetry test. 3) To determine the percentage of the glaucoma diagnosis using OCT in patients with unreliable standard automated perimetry.
Materials and Methods: A cross-sectional observational study was conducted on 100 glaucoma suspect patients. In glaucoma suspects, age, gender, locality, education, occupation & economic status were recorded. 30-2 central fast threshold visual field was done for 2 consecutive times. On OCT percentage of optic disc cupping, RNFL thinning were calculated & analyzed in patients with unreliable SAP
Results: Mean age group- 52 ± 7 years. 60% had unreliable SAP. 40 cases were in age 51-70years. 39 cases were from rural locality & 21 from urban. Most of them were farmers. 22 cases were illiterate. 50 cases were from lower socio-economic status. 35 cases had RNFL thinning
Conclusion: 60% of individuals had unreliable SAP results. Most cases of unreliable perimetry were observed in females, age group of 51-60 years, predominantly from rural areas, engaged in farming or homemaking, with low literacy levels and a lower socio-economic status. Among these individuals, 58% were diagnosed having glaucoma using OCT, highlighting the effectiveness OCT in diagnosing glaucoma in this group.

1. Introduction

Glaucoma is a multifactorial, chronic optic nerve neuropathy that is characterized by progressive loss of retinal ganglion cells (RGC), which leads to structural damage to the optic nerve head (ONH), retinal nerve fiber layer (RNFL) and consequent visual field defects.[1] As the population ages and average life expectancy increase, the prevalence of this debilitating disease will rise. Glaucoma is a leading cause of blindness among working-age individuals in industrialized countries and is the most common cause of permanent vision loss in people over age 40, second only to age-related macular degeneration.[2]

Early diagnosis and treatment of glaucoma has been shown to reduce the rate of disease progression and improve patient's quality of life.[3] Given the insidious and

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unpredictable progression of glaucoma, it is crucial to monitor disease severity through regular assessments. There is no gold standard test to evaluate progression. Visual field (VF) testing is essential in tracking functional loss but is subjective and has poor reproducibility, requiring a series of many tests to establish progression.[4]

Optical Coherence Tomography (OCT) has been extensively utilized to measure the thickness of the nerve fiber layer (NFL) and ganglion cell complex (GCC), both of which strongly correlate with glaucoma stages.[5] Studies have shown that OCT can diagnose glaucoma with fair to good accuracy and can enhance the prediction of progression from pre-perimetric to perimetric glaucoma as well as the worsening of visual fields. It is currently believed that visual field (VF) testing provides more valuable information in established glaucoma, especially in moderate to advanced stages. Conversely, OCT is generally considered more sensitive in detecting disease progression in its earlier stages. Optical coherence tomography (OCT) is objective and precise[6] but is thought to be less useful in advanced glaucoma due to the "floor effect" of nerve fiber layer (NFL).[7,8]

Standard Automated Perimetry (SAP) is an essential test for diagnosing and monitoring glaucoma. However, since SAP is a subjective test, its results are susceptible to variability. The variability of SAP test results depends on many factors. A well-known factor is disease stage.[9,10] Other factors are patient motivation and technician performance, the latter via appropriateness of refraction and patient instruction, reassurance before the test, and patient monitoring during the test.[11,12] Limitations such as anxiety, fatigue, distraction, and lack of familiarity with the test can lead to a higher percentage of unreliable SAP results, particularly among rural and less educated population. OCT being an objective test, could prove beneficial in illiterate and rural populations.

2. Materials and Methods

A cross-sectional observational study was conducted on 100 glaucoma suspect patients after obtaining informed and written consent. The study included all diagnosed cases of primary open-angle glaucoma (POAG) and glaucoma suspect cases i.e. disc suspects and intraocular pressure (IOP) suspects. Patients with dense cataract, leucomatous corneal opacity, aphakia, pseudophakia, nystagmus, amblyopia, and other retinal pathologies were excluded from the study. Detailed medical histories, including sociodemographic data, were collected: age, gender, locality, education, occupation, income, and socioeconomic status. Comprehensive ophthalmologic examination was performed, which included best-corrected visual acuity assessment using a Snellen chart, slit-lamp examination to evaluate the depth of the anterior chamber using the Van Herick method, as well as cataract grade and corneal status. Intraocular pressure measurements taken with a Perkins tonometer, with corrected IOP calculated after measuring central corneal thickness, indirect gonioscopy using a single Goldmann mirror, dilated fundus examination using indirect ophthalmoscope with a 20D lens, and slit-lamp biomicroscopy using a 90D lens.

Visual field testing using the Humphrey Field Analyzer with the fast threshold central 30-2 strategy, conducted twice consecutively by a single examiner after giving proper instructions to the patient. Visual fields were considered reliable if fixation loss was < 20%, false positives and false negatives were < 33%.

Structural analysis of the retinal nerve fiber layer (RNFL) was performed using optical coherence tomography (OCT) in cases where standard automated perimetry (SAP) results were unreliable. The parameters assessed with Optical Coherence Tomography (OCT) for structure-function comparisons include peripapillary retinal nerve fiber layer (RNFL) thickness and probability maps of RNFL thickness.

3. Results

The mean age group of the patients in the study was 52.7 ± 7.43 years.

Out of 100 glaucoma suspects, 48% were male and 52% were female. 60% of perimetry results were unreliable.

2(3%) unreliable cases were in age group 31-40 yrs. 21(35%) unreliable cases were in age group 41-50 yrs. 27(45%) unreliable cases were in age group 51-60 yrs. 10(16%) unreliable cases were in age group 61-70 yrs.(Table 1)

Table 1: Age distribution in unreliable SAP

Age	No of Unreliable Cases	Percent
31-40	2	3.3
41-50	21	35.0
51-60	27	45.0
61-70	10	16.7
Total	60	100.0
Mean & SD	53.4 ± 7.16	

Out of 6 cases, 2 unreliable cases in age group 31-40 yrs. Of 34 cases, 21 unreliable cases in age group 41-50 yrs. Out of 47 cases, 27 unreliable cases in age group 51-60 yrs. Of 13 cases, 10 unreliable cases in 61-70 yrs.

Table 2: Locality of cases

Locality	No of Cases	No of Unreliable Cases	Percent
Rural	54	39	65.0
Urban	46	21	35.0
Total	100	60	100.0

Out of 54 rural cases, 39(65%) cases had unreliable SAP. Out of 46 urban cases, 21(35%) cases had unreliable SAP.

(Table 2)

Table 3: Education in unreliable cases

Education	No of Cases	No of Unreliable Cases	Percent
Illiterate	24	22	36.7
Primary school	24	18	30.0
Middle school	7	4	6.7
High school	19	8	13.3
Intermediate	12	6	10.0
Degree & above	14	2	3.3
Total	100	60	100.0

Out of 24 Illiterate cases, 22(37%) cases had unreliable SAP. Out of 24 cases who completed primary schooling, 18(30%) cases had unreliable SAP. Out of 7 cases who completed middle school, 4(7%) cases had unreliable SAP. Out of 19 cases who completed high school, 8(13%) cases had unreliable SAP. Out of 12 cases who finished intermediate, 6(10%) cases had unreliable SAP. Out of 14 cases who graduated, 2(3%) cases had unreliable SAP.(Table 3)

Table 4: Socio economic status in unreliable SAP

SES	No of Cases	No of Unreliable Cases	Percent
Upper	8	1	1.7
Upper middle	25	9	15.0
Upper lower	28	26	43.3
Lower middle	39	24	40.0
Total	100	60	100.0

Out of 8 cases in upper class, 1(2%) case had unreliable SAP. Of 25 cases in upper middle class, 9(15%) cases had unreliable SAP. Of 28 cases in upper lower class, 26(43%) cases had unreliable SAP. Out of 39 cases in lower middle class, 24(40%) cases had unreliable SAP. (Table 4)

Most of the 23(39%) unreliable cases were farmers followed by 18(30%) homemaker. Least 1(2%) cases were seen in occupation like teacher and clerk. No unreliable cases were seen in occupations like shopkeeper, driver and engineer.(Table 5)

On optic disc OCT, 15(25%) unreliable cases had cupping in range 0.51-0.6. 30(50%) unreliable cases had cupping in range 0.61-0.7. 11(18%) unreliable cases had cupping in range 0.71-0.8 and 4(7%) unreliable cases had cupping in range 0.81-0.9.

Out of the 60% of cases with unreliable perimetry who underwent Cirrus HD OCT, 35(58.3%) exhibited retinal nerve fiber layer (RNFL) thinning. 9(25.7%) cases with RNFL thinning had disc cupping in range 0.51-0.6. 18(51%) cases with RNFL thinning had disc cupping in range 0.61-0.7. 7(20%) cases with RNFL thinning had disc cupping in range 0.71-0.8. 1(3%) case with RNFL thinning had disc cupping in range 0.81-0.9.(Table 6)

Table 5: Distribution of occupation in unreliable SAP

Occupation	No. of Unreliable Cases	Percent
Farmer	23	38.3
Homemaker	18	30.0
Laborer	7	11.7
Shopkeeper	0	0.0
Tailor	2	3.3
Teacher	1	1.7
Business	2	3.3
Driver	0	0.0
Engineer	0	0.0
Bank manager	3	5.0
Carpenter	2	3.3
Clerk	1	1.7
Others	1	1.7
Total	60	100.0

Table 6: Optic disc cupping to RNFL in unreliable cases

Optic Disc cupping in unreliable patients	RNFL <93 in unreliable patients	Percent
0.41 - 0.50	0	0.0
0.51 - 0.60	9	25.7
0.61 - 0.70	18	51.4
0.71 - 0.80	7	20.0
0.81 - 0.90	1	2.9
Total	35	100.0

4. Discussion

Visual field analysis is an important component in the diagnosis and management of glaucoma. Automated perimetry provides an objective method of quantifying field loss, but the interpretation of the results depends on the reliability of the visual field, which in turn is based on the quality of the patient's performance. Performance by a patient can be assessed quantitatively using the standard HVF reliability indices: Fixation loss, false-negative error, and false-positive error.[13] Our study showed that 60% of the patients had unreliable perimetry results on Humphrey field analyzer using fast threshold 30-2 for two consecutive times. Most of these patients with unreliable fields were in age group of 51-60 years. These observations were consistent with study conducted by Catherine M. Birt et al.[14] where they found that age correlated significantly with increased FL.

We observed that 39(65%) unreliable cases were from rural locality in our patient population. Similar observations were seen in study conducted by Catherine M. Birt et al.[14]

where the majority of the patient population came from the inner city and had relatively high rate of unreliable fields. We found that occupations like 23(38.3%) farmers, 18(30%) homemakers, and 7(11.7) laborers showed a higher prevalence of unreliable fields compared to 1(1.7%) clerks, 1(1.7%) bank managers, and 1(1.7%) teachers, suggesting that greater familiarity and understanding of the test led to more favorable outcome.

We noticed that the higher proportion of unreliable cases among 26(43.3%) upper lower class and 24(40%) lower middle class, compared to the lower incidence among the 1(1.7%) upper class and 9(15%) upper middle class, implies a direct correlation between socioeconomic status and the reliability of perimetry test.

The parameters assessed with Optical Coherence Tomography (OCT) for structure-function comparisons include peripapillary retinal nerve fiber layer (RNFL) thickness and probability maps of RNFL thickness. Patients with unreliable visual field tests underwent Spectral-Domain OCT (SD-OCT). Out of the 60% of cases analyzed, 35 (58.3%) exhibited RNFL thinning. The highest prevalence of RNFL thinning was observed in the age group of 51-60 years. It was found that OCT was superior in the early detection of glaucoma in this population, which correlates with a study conducted by Hence Naveed Nilforushan et al,[15] where they found that structure-function relationships can be detected in early glaucoma with SD-OCT.

Among patients with unreliable standard automated perimetry (SAP), 18(51.4%) exhibited RNFL thinning, along with an average cup disc ratio of 0.61-0.70 in optic disc nerve head evaluation by OCT. This suggest that assessing optic nerve head (ONH) parameters and RNFL thickness provides a higher probability of early diagnosis in this population with unreliable SAP.

Out of the 60% unreliable cases, 35 (58.3%) exhibited RNFL thinning. It was found that OCT was superior in the early detection of glaucoma in this population, which correlates with a study conducted by Naveed Nilforushan et al,[15] where they found that structure-function relationships can be detected in early glaucoma with SD-OCT.

5. Conclusion

60% of individuals had unreliable SAP results. Most cases of unreliable perimetry were observed in females, age group of 51-60 years, predominantly from rural areas, engaged in farming or homemaking, with low literacy levels and a lower socio-economic status. Among these individuals, 58% were diagnosed having glaucoma using OCT, highlighting the effectiveness OCT in diagnosing glaucoma in this group.

6. Source of Funding

None.

7. Conflict of Interest

None.

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